

WHAT IS CLAIMED IS:

- 1 1. A control module for controlling fuel delivery in a fuel
2 injector comprising:
3 a control module housing defining a cavity containing a fluid;
4 an armature disposed at least in part within the cavity, the armature
5 movable within the cavity, the armature operative to affect the flow of fuel by
6 changing the area of a fuel port through which fuel passes;
7 a drive for moving the armature, the drive operative to move the
8 armature towards a contact wall of the cavity; and
9 a fluid passage formed as the armature moves towards the contact
10 wall, the fluid passage remaining open to pass a minimum volume of fluid;
11 wherein armature vibration is dampened as fluid moves through the
12 fluid passage.
- 1 2. A control module as in claim 1 wherein the fluid passage is
2 formed by a dampener sleeve extending from the armature towards the contact wall.
- 1 3. A control module as in claim 2 further comprising a stop
2 extending from the armature towards the contact wall, the stop extending farther
3 than the dampener sleeve such that, when the stop contacts the contact wall, the
4 fluid passage forms a minimum passage gap between the dampener sleeve and the
5 contact wall.
- 1 4. A control module as in claim 2 wherein the fluid passage is
2 formed by at least one notch in the dampener sleeve.
- 1 5. A control module as in claim 1 wherein the fluid passage is
2 formed by a channel in the contact wall.
- 1 6. A control module as in claim 1 wherein the armature has a
2 compression side facing the contact wall, the fluid passage formed between a
3 dampener shim on the contact wall and the compression side.

1 7. A control module as in claim 6 wherein the compression side
2 is circular and the dampener shim defines a circular opening having an opening
3 radius smaller than the compression side radius.

1 8. A control module as in claim 7 further comprising a stop
2 extending from the compression side towards the contact wall a distance greater than
3 the thickness of the dampener shim.

1 9. A control module as in claim 1 wherein the armature defines
2 a shoulder at least partially around the armature, the fluid passage formed between
3 a dampener sleeve extending from the contact wall and the shoulder.

1 10. A control module as in claim 1 wherein the housing further
2 defines a second cavity within which is at least partially disposed a second armature,
3 the second armature forming a second fluid passage, wherein fluid exiting the
4 second armature cavity through the second fluid passage provides dampening of the
5 second armature.

1 11. A control module as in claim 1 wherein the fluid passage
2 remains open when the armature contacts the contact wall.

1 12. A method of controlling a flow of fuel in a fuel injector
2 comprising:
3 moving at least a portion of an armature in a cavity containing fluid;
4 changing an opening area of a fuel port through the movement of the
5 armature, thereby affecting the flow of fuel;
6 forming a fluid passage for passing fluid between the armature and
7 a wall defining the cavity as the armature moves towards the wall;
8 increasing fluid pressure as the fluid passage forms; and
9 dampening armature vibration through the increasing fluid pressure.

1 13. A method of controlling a flow of fuel in a fuel injector as in
2 claim 12 wherein forming a fluid passage comprises:
3 moving a dampener sleeve extending from the armature in a direction
4 of armature motion; and
5 contacting a wall defining the cavity with a stop extending from the
6 armature in the direction of armature motion farther than the dampener sleeve.

1 14. A method of controlling a flow of fuel in a fuel injector as in
2 claim 12 wherein forming a fluid passage comprises:
3 moving a dampener sleeve extending from the armature in a direction
4 of armature motion, the dampener sleeve defining at least one notch; and
5 contacting the wall with the dampener sleeve.

1 15. A method of controlling a flow of fuel in a fuel injector as in
2 claim 12 wherein forming a fluid passage comprises capping a portion of a channel
3 formed in the wall.

1 16. A method of controlling a flow of fuel in a fuel injector as in
2 claim 15 wherein capping a portion of the channel comprises contacting the wall
3 with a sleeve extending from the armature.

1 17. A method of controlling a flow of fuel in a fuel injector as in
2 claim 12 wherein forming a fluid passage comprises narrowing a gap between the
3 armature and a dampener shim extending from the wall.

1 18. A method of controlling a flow of fuel in a fuel injector as in
2 claim 17 wherein the armature has a compression side facing the wall and wherein
3 the dampener shim defines an opening facing the compression side, the opening
4 smaller than the compression side.

1 19. A method of controlling a flow of fuel in a fuel injector as in
2 claim 18 further comprising contacting a valve stop between the armature and the
3 wall to prevent the gap from closing.

1 20. A method of controlling a flow of fuel in a fuel injector as in
2 claim 12 wherein forming a fluid passage comprises narrowing a gap between a
3 shoulder on the armature and a dampener sleeve fixed within the cavity.

1 21. A method of controlling a flow of fuel in a fuel injector as in
2 claim 20 further comprising contacting a valve stop to prevent the gap from closing.

1 22. A fuel injector comprising:
2 an injector body defining a fuel outlet;
3 a fuel delivery path for delivering pressurized fuel to the fuel outlet;
4 and
5 a control module connected to the fuel delivery path, the control
6 module including at least one solenoid for controlling fuel delivery, each solenoid
7 having an armature biased by a spring to contact a wall defining a cavity when the
8 solenoid is not energized, the armature and the wall forming a passage as the
9 armature approaches the wall, the passage passing fluid to dampen vibrations caused
10 by the armature contacting the wall.

1 23. A method of injecting fuel into an engine comprising:
2 compressing the fuel;
3 supplying the compressed fuel to an opening in an injector through
4 a controlled path;
5 activating a solenoid in the injector to control the flow of fuel along
6 the path, the solenoid having an armature traveling through a fluid containing
7 cavity;
8 deactivating the solenoid causing the armature to approach a wall
9 defining the cavity;
10 forming a passage as the armature approaches the wall;
11 passing fluid from between the armature and the wall through the
12 passage; and
13 dampening vibrations by passing the fluid.

- 1 24. A method of injecting fuel into an engine comprising:
2 compressing the fuel;
3 supplying the compressed fuel to an opening in an injector through
4 a controlled path;
5 activating a solenoid in the injector to control the flow of fuel along
6 the path, the solenoid having an armature traveling through a fluid containing
7 cavity;
8 deactivating the solenoid causing the armature to contact a wall
9 defining the cavity;
10 forming a passage as the armature contacts the wall;
11 passing fluid from between the armature and the wall through the
12 passage; and
13 dampening vibrations by passing the fluid.